LETTERS TO THE EDITOR.

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Psychophysical Interaction.

SINCE NATURE is read by many people beside physicists and mathematicians, it may be useful to state explicitly that a letter with a diagram, on p. 102, is erroneous and misleading.

For the same reason it may be desirable to remark distinctly, in opposition to a notion *apparently* suggested by several previous writers, that guidance or deflection of motion is not in the least contradictory of the principle of the conservation of momentum. For the rest, all the letters of importance which have recently appeared are in accordance with my views. OLIVER LODGE.

I HAVE followed with much interest the discussion opened in your columns by Sir Oliver Lodge's recent contention that mind directs but does not create energy. What is aimed at, as I understand it, by this distinction is the reconciliation of the activity and efficiency of mind with the mechanical laws of the conservation of energy and momentum. The distinction itself is, as is well known, as old as Descartes, being designed by him to meet the same problem as it presented itself to the thinkers of the seventeenth century. As is also well known, it was immediately disowned by his successors on the ground that guidance or direction of energy by the mind is an interference with the operation of material forces as the physicist is bound to conceive of them not less than the creation of it. Why is it more inconceivable that mind should alter energy or momentum than that it should interfere in any way whatever with the material world as a closed mechanical system? While to Sir Oliver Lodge it seems axiomatic that mind cannot produce energy, to others it has seemed equally axiomatic that it cannot resist or control it. It remains, therefore, for those who propose to revive the above distinction as a way of making the relation of mind to matter comprehensible to show by an analysis of the conception of control that the direction of physical energy by the mind is any more intelligible than its creation. Failing this, the problem they have sought to solve by means of this formula only returns in a deeper form. How is mental efficiency in any shape to be reconciled with fundamental mechanical principles? The purpose of this letter is to suggest a form of solution, somewhat different from that of Prof. Ward's in his "Naturalism and Agnosticism," which makes recourse to so ambiguous a distinction unnecessary.

Stated in its most general form, the problem is that of the operation of mind upon matter. Three answers have stood out owing to the authority of those who at different times have advocated them :—

(1) It has been held that mind and matter are each in its own sphere effectively operative, but that these spheres are wholly different. They never touch or intersect. Where there appears to be coincidence, as in knowledge or in the action of one upon the other, this is to be explained (if an explanation is insisted on) as the result of pre-arrangement. Except in the form of the working hypothesis of parallelism, no responsible thinker would probably accept this "dualistic" theory at the present time, and it need not further be considered.

(2) The second answer is that which explains mental activity as merely apparent. The really active forces are material. Consciousness is merely a by-product, standing to material forces as the steam which is dissipated in the air stands to the steam-engine—a sign of its operation, but itself contributing nothing to its efficiency. This "materialistic" theory is surrounded by difficulties which this is not the place to discuss, but which the present generation seems to be in the main agreed are insuperable.

(3) A third view remains which takes up the problem at an earlier point, and asks whether our difficulty is not a self-made one. If we set out from the existence of mind and matter as two entirely separate substances, there is, it must be admitted, no way in which we can establish any continuity or causality between them. On the other hand, if we reverse this assumption, and regard the conception of two worlds, a physical and a mental, as one that grows up within (it is not said created by) our experience, a way seems opened up out of the difficulty. The conservation of energy and momentum, and the determination of their direction by physical antecedents, are from this point of view conceptions which are forced upon us in our endeavour to interpret to ourselves one side or aspect of our experience—that which we call the mechanical. Within the area so describable they are universal, ultimate, admitting of no exception. But the mechanical is only one side of our experience. Besides mechanical energy there is life. The phenomena of life violate no mechanical law, yet open up to us a new aspect of our world, a new form of "energy." We may, indeed, try to "explain" life as only a more complex mechanism, and this has been a common device since the time of Descartes. But the present day tendency to recognise here a *transitio in aliud genus*, and to reject (as leading to confusion) the attempt to explain the fuller, more concrete reality by formulæ applicable only to the more abstract, seems to be founded on a truer insight. What holds of the relation of life to mechanism holds also of the relation of mind to life in general. Here also a new world opens up with laws of its own, no more identifiable with those of matter or organism than the system of mechanical forces which make up the movement of the billiard ball upon the table or the contraction of the muscles in the player's arm is identifiable with his acquired dexterity or his gaming ambition.

"But how," it may be asked, "does all this help us? Granted the world of Nature has these different 'sides,' we are no nearer understanding how any one side is connected with another, least of all how the 'world as will and idea' is connected with the world as matter and energy." It is just here that I wish to invite the physicist who may not have considered the question in this light to make an experiment with his ideas which may not hitherto have suggested itself, and when suggested may appear to him as ridiculous as an invitation to vary his outlook upon the universe in the interest of science by standing upon his head. The suggestion is that instead of starting, as probably he has been accustomed to do, from the presupposition that the entirely real and concrete is what is known as the physical world, and that everything else must fall into line as in some sense a product or reflection of it, he should start from his own experience as a whole—his mind and will as it exercises itself in the world of reality in general, including, of course, other minds and wills—as though this were the primary, most entirely real and concrete fact that he knows, and regard all else as comparatively abstract and secondary. The former view I invite him to consider for the time being as analogous to the old Ptolemaic astronomy, the latter as the Copernican. When he has done so I ask him further to consider whether the operation of mind on matter need any longer constitute the insoluble problem the older hypothesis made of it. Putting aside the question of the relation of our individual minds to the mind of the Creator, the single "real" activity is from this point of view that of a conscious will in presence of a universe which it is its one supreme interest to understand and adapt to its own ends of life and well-being. The condition of such understanding and adaptation is selection and abstraction; its one supreme law *divide et impera*. A fundamental division at which developing experience early arrives is that of an inner and an outer—a self and other. A subdivision of the latter, which it is not long in achieving, is into the material other and the mental other—the physical and the social world. In this way the division proceeds, but always into parts of a whole of which we must keep a hold and to which we must ever return wherever the danger threatens of becoming the victim of our own abstractions. Treated as an articulate part of the whole, each field falls into its place in the organism of experience—general philosophy being the attempt to state what that place is; when hypostatised into an independent reality, still more when mistaken for the whole it leads only to confusion. From the beginning of speculation the front of the offending has here lain with Matter. Philo-

sophy from the time of Plato has had its own way of meeting it on its own ground, and disposing of its exclusive claims. I do not write here in the interests of transcendentalism, but merely to invite the attention of physicists to a point of view which students of modern psychology have borrowed from it, and are now generally seeking to apply to the problem of the relation between mental and physical energy. J. H. MUIRHEAD.

Birmingham, June 9.

Seismometry and Gëite.

HAD Dr. Chree (NATURE, May 21, p. 55) referred to the various papers about earthquakes in the reports of the British Association commencing in 1847 by William Hopkins, in the now somewhat antiquated *Transactions* of the Seismological Society of Japan, and in very many other publications relating to earthquakes, he would have seen that his instructive remarks relating to the propagation of waves in an isotropic medium were but repetitions of information with which seismologists have at least a slight acquaintance, whilst the suggestion that the velocities of such waves have been regarded as having a direct connection with Young's modulus is incorrect.

In connection with Bessemer steel, Young's modulus was mentioned, but I do not see that it was referred to repeatedly (NATURE, April 9, p. 538). In 1897 Dr. Chree made an attempt to calculate Young's modulus and the bulk modulus for the earth, but the grist he used was so doubtful in character that his results are not convincing. From some source or other he discovered that wave velocities of 12·5 and 2·5 km. per second had been determined, and these were assumed to be V_1 and V_2 for compressional and distortional waves passing *through* the world. One, if not both of these, are based upon *arcual* measurements; they are incorrect at that, and the latter seems more likely to represent the velocity of a surface undulation rather than a quantity corresponding to V_2.

What I pointed out was that recent determinations of a quantity probably corresponding to V_1 find a simple explanation by the assumption of a core that is fairly *homogeneous* and of fairly *definite dimensions*, which is not the solution of the seismological problems attempted by Dr. Chree. The reference to elastic moduli was incidental.

The chief objection raised to the iron core is not that iron, as we know it, will not convey vibrations at the observed speeds, but that if we take such a core, gravitational and astronomical requirements appear to be such that it must have dimensions which do not altogether accord with the interpretation given to seismometrical observations.

What Dr. Chree tells us about the possible relationship between seismic disturbances and the movements of magnetic needles is as well known to seismologists as what he has to say about wave velocities. Many of the chief magnetic observatories of the world have compared their magnetograms with long lists of world-shaking and other earthquakes, and the results are to be found in the British Association Reports, 1888 and 1889. From Dr. Chree's own comparisons at Kew (British Association Report, 1888, pp. 229 and 231, &c.), the movements he discovered were, with two possible exceptions, of "the ordinary magnetic small wave type," which "go on for hours if not for days." My conclusion is that at Kew, Greenwich, &c., needles seem not to be disturbed at the time of large earthquakes in the manner in which they are disturbed at Bombay and other places. At these latter places, where the movement of needles apparently accompanying the passage of the large waves indicates a possible magnetic disturbance directly due to seismic causes, the inference I made was that at such places H.F. and $(g-\gamma)$ may be abnormal. As an illustration of the coexistence of the *three* phenomena we may take the following :—

	H.F. (c.g.s.)	$(g-\gamma)$ cm.	Earthquake effect on magnetic needles
Kew	0·18451 (1901)	+ 40 (1900)	Undisturbed.
Batavia	0·36752 (1898)	+136 (1894)	Disturbed.

Whether these coincidences are accidental or general, observations are yet required. JOHN MILNE.

THE VITALITY OF THE TYPHOID BACILLUS.[1]

THE object of hygiene is to prevent disease. It is therefore necessary that the factors in the causation and dissemination of disease should be understood in order that adequate preventive measures may be adopted. The living agents responsible for the production of infectious diseases when they are discharged from affected individuals may find their way back to the human body by a number of indirect channels. The water, the soil, or the food may at times harbour and transmit the germs of disease. The conditions under which these morbid agents exist in the outside world constitute one of the most important subjects of hygienic inquiry. It cannot be said with regard to this phase in the life-history of pathogenic organisms that our knowledge is as accurate or extensive as it is in other directions. This is due to the difficulties that stand in the way of such investigations. The germs of disease undergo an enormous dilution in the air, water and soil, whilst they tend to become lost in the crowd of similar forms already existing in nature. The facts so far support the view that the parasitic microorganisms possess a considerable amount of resistance to external influences, and that the links which ensure their conservation and retransference to man are numerous and varied. A typical example is the bacillus of typhoid fever. This organism may become widely distributed through the dejecta. It may contaminate a water supply and directly, or by the agency of milk, produce a fresh outbreak of typhoid fever. It may infect the soil, and through it a number of raw vegetable foods. Its presence has been detected in the sewage-fed oyster, whilst tainted dust and flies aid in the distribution of the organism.

In studying the distribution of enteric fever, a physical factor which has to be considered is the influence of cold on the vitality of the specific organism. The effect of low temperatures upon microorganisms generally has formed a subject of inquiry from time to time. The latest experimental work has conclusively shown that bacteria retain their vitality under the most adverse conditions of cold that it is possible to devise. Prof. Sedgwick and Mr. Winslow, approaching the subject from the hygienic point of view, have carefully studied the influence of natural and normal conditions of cold upon the typhoid bacillus in particular. Their experiments were carried out with special reference to the danger of conveyance of the disease in question by polluted ice, and with reference to the seasonal distribution of the disease. The matter was undoubtedly one that called for investigation, and notably in a country where ice and iced drinks are in such universal demand. The authors were unable to find any recorded evidence of a conclusive character as to the spread of typhoid fever by a polluted ice supply, although it has been a common opinion that ice might be an important source of infection for typhoid fever and other intestinal diseases.

The apparent purity of ice is deceptive. It is true that water in freezing undergoes a certain amount of purification. It loses, on conversion into ice, saline constituents, contained air, and a certain proportion of organic suspended matter. At the same time, it is not entirely freed from microbes. The figures quoted by Prof. Sedgwick and Mr. Winslow show that snow-ice may contain an average of more than 600 bacteria per cub. cm. Figures are also given to indicate the enor-

[1] Experiments on the Effect of Freezing and other Low Temperatures upon the Viability of the Bacillus of Typhoid Fever, with Considerations regarding Ice as a Vehicle of Infectious Disease" By William T. Sedgwick, Ph.D., Professor of Biology, and Charles-Edward A. Winslow, S.M. Instructor in Biology in the Massachusetts Institute of Technology (*Memoirs* of the American Academy of Arts and Sciences, vol. xii. No. 5, 1902.)